JSAMs

Joint Strength Analysis Modules;

JSAMS:

Jsams are a set of Visual Basic modules offering quick and easy methods to parametrically assess Joint strength of self-piercing rivet and/or combined adhesively bonded lap and T-Peel joints under tension loads. The Jsams are suitable for most ductile materials.

The JSAMs modules have been designed to accommodate the specific rivet shape, such as that offered by Clevedon, Bollhoff, Ariel and Henrob self-piercing rivets, used by the automotive industry.

JSAMs enable many variations of Lap and T-Peel joint geometry to be structurally explored very quickly, thereby immediately assisting Car Designers and Engineers in their rivet reduction/optimisation programs. The parametric studies on joints that take minutes in JSAMS would take hours to obtain by either testing or the use of Finite element analysis.

The use of JSAMs provide the Engineer with closed form solution tools, to assess the Joint strength and failure mode of virtually any practical variation of Joint/rivet/adhesive configuration.

BENEFITS of JSAMS.

- Minimize the need for joint strength testing.
- Modules tailored for Self-piercing rivets, the type used in the automotive industry.
- Quick and easy Parametric joint strength sensitivity analysis studies.
- Joint strength and failure modes shown and predicted Failure modes displayed include;

a) Bearing failure.
b) Shear Failure.
c) Net Tension Failure.

Optimisation of any Lap joint/rivet/adhesive configuration and material combination. Optimise for;

a) Rivet count minimisation.
b) Rivet type minimisation.
c) Joint strength and failure mode.
d) Joint width required to sustain specific loading.

- Joint geometry may be varied until the optimum joint strength is achieved.
- Determine joint failure strength and failure mode for existing joints. Helpful when trouble shooting.
- Jsams calculate Rivet parameters required for DYNA-3D crash analysis.
- Jsams calculate the Rivet parameter required for ACM2 (Nastran)

RIVET MANUFACTURERS:

The JSAMs are applicable to joints using rivets manufactured by;

- Clevedon Fasteners Ltd
- Bollhoff Rivet Fastenings Ltd.
- Henrob Rivet Fastening systems Ltd
- Ariel Rivet Fastening systems Ltd.
- Avdel Textron Fastening systems Ltd.

INDUSTRIES WHERE JSAMs MAY BE APPLICABLE:

These VB application tools can be used by industries such as;

- Aerospace
- Automotive
- Ship building
- Rail-Rolling stock
- Container
- Domestic utilities, eg washing machines, fridges

AUTOMOTIVE:

Many automotive manufacturers are now seriously examining the production of lightweight vehicle concepts, which may offer benefits of emissions and fuel performance. Lightweight materials being considered such as aluminium and composites materials such as carbon or glass fibre. It is apparent that the most likely method of joining such materials is by the use of self-piercing rivets, adhesives or a combination of both. Other material options lending themselves to this cold-joining technique include, steel/plastic and aluminium/steel.

A typical aluminium bodied family saloon car fastened together using rivets, is likely to contain between 4000 to 8000 steel rivets. Not only is an excess of rivets in the vehicle an unnecessary weight burden, but a higher rivet count per vehicle also requires more robotic assembly installations, with their inherent cost of installation and maintenance. Unit vehicle cost can then be very sensitive to influences of rivet numbers. During conceptual design of say aluminium vehicles, invariably the Engineer will be faced with panel joint optimisation. Testing programs can provide joint failure data and Finite Element analysis is an excellent analytical/design tool. However, the number of materials and/or riveted joint/adhesive combinations required to obtain statistical usable joint test data can demand expensive and comprehensive testing programs. So it is not always possible for the vehicle Engineer to obtain the joint strength data at the time he requires it.

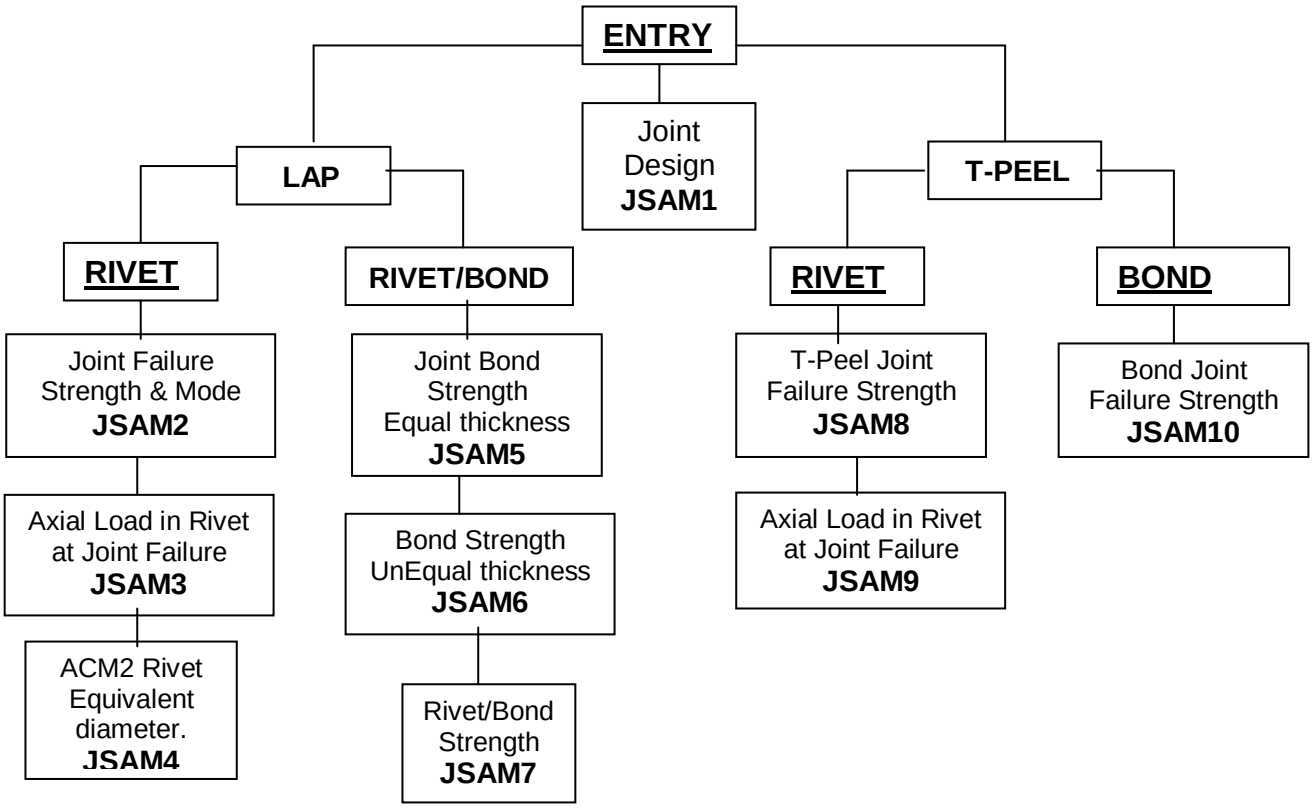
However, JSAMs can provide predicted joint strength values, which enable the engineer to conduct immediate parametric and joint strength optimisation studies.

JSAM MODULES:

1. Rivet Lap Joint design:	Preferred Bearing mode failure
2. Rivet Lap Joint.	Ultimate Failure Strength and failure mode.
3. Rivet Lap Joint.	Axial load in Rivet at joint failure. (Dyna crash requirement.)
4. Rivet Lap Joint.	ACM2. Rivet equivalent diameter.
5. Adhesive Lap Joint.	Elastic Failure strength. Equal thickness adherands.
6. Adhesive Lap Joint.	Elastic Failure strength. Unequal thickness adherends.
7. Rivet/Adhesive Lap joint	Rivet/adhesive strength combinations and failure mode.
8. T-Peel Joint.	Axial load in Rivet at joint failure. (Dyna crash requirement.)
9. T-Peel Joint.	Rivet T-PEEL Joint Ultimate Failure Strength.
10. T-Peel Joint	Adhesively Bonded T-PEEL Joint Ultimate Failure Strength.

MODULE NAVIGATION:

Access to the specific modules is icon driven.



JOINT INPUT VARIABLES:

The joint parameters that may be varied in the calculation input include;

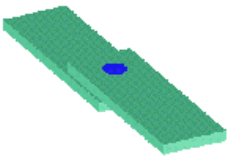
- Joint width.
- Joint thickness.
- Equal thickness adherends
- Unequal thickness adherends.
- Number of adherands. (More than two coupons can be used)
- Joint overlap.
- Joint materials. Note: Top and bottom adherends may be of different materials.
- Young's Modulus.
- Material strength.
- Rivet to edge distance.
- Rivet diameter.
- Number of rivets.
- Rivet materials.
- Adhesive strength.
- Adhesive shear modulus.
- Adhesive laid down thickness.

MATHEMATICAL ANALYTICAL BASIS:

The mathematical analysis within Jsams are based on, and referenced to Public Domain data and stress analysis procedures. Such methods are found in publications, books relating to structural analysis and material performance data. The modules can be ‘fined tuned’ depending upon the end user requirements.

Jsam results are usually accurate to within a few percent of test data. It is obviously important that the end user employs accurate material and geometric data when using Jsams. SI units have been used throughout the development of the Jsams.

JSAM1: RIVETED LAP JOINT DESIGN: Based on Bearing Failure Strength.



This Jsam1 module, is a simple optimiser. It is based on the preferable Bearing mode of joint failure.

APPLICATION: For a specific tensile load, this Jsam Is intended to assist the car body designer, in determining;

- the rivet lap joint geometry.
- the number of rivets.
- Rivet edge distance.

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The two coupon adherends are assumed to have the same material and thickness properties.

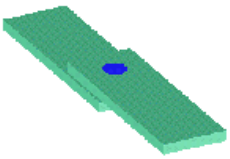
JOINT ADHEREND INPUT VARIABLES:

- Joint coupon thickness
- Rivet diameter
- Rivet material.
- Joint materials. Material Strength.
- Applied Tensile load.

OUTPUT: Ultimate failure strength and mode of failure of riveted joint.

- Number of rivets.
- Joint width.
- Rivet to joint edge distance.

JSAM2: RIVETED LAP JOINT STRENGTH.



This JSAM2 application calculates the failure load strength of a riveted Lap joint and also displays the Failure mode. Failure modes displayed include;

- Bearing Failure.
- Shear out Failure.
- Net tension failure.

APPLICATION: The Designer or Stress Engineer can use the JSAM2 tool to;

- Determine joint failure strength and mode for existing joints. Helpful when trouble shooting.
- Conduct parametric and Optimisation studies relating to joint/rivet geometry variations.
- Rivet minimisation studies, ie Reduction of rivet count.

OPTIONS: Joint geometry/rivet configuration may be varied until the optimum joint strength is achieved.

JOINT INPUT VARIABLES: Virtually any variation of Joint/rivet configuration may be quickly explored for strength and failure mode. The parameters that may be varied in the calculation include;

- Joint width.
- Joint thickness. Note, that unequal joint coupon thickness are accepted.
- Coupon Stacks of more than two can be used. (See tutorial).
- Joint overlap.
- Joint materials.Note, Top and bottom coupons may be of different materials.
    a) Youngs Modulus.
    b) Material Strength.
- Rivet to joint edge distance.
- Rivet diameter.
- Number of rivets.
- Rivet material.

OUTPUT: Ultimate failure strength and mode of failure of riveted joint.

JSAM3: RIVET AXIAL LOAD AT LAP JOINT FAILURE

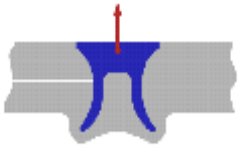
This JSAM3 tool calculates the Load in the rivet of the riveted Lap joint at joint failure.

APPLICATION: This rivet load is then used in crash analysis software such as DYNA or other crash analysis software.

JOINT INPUT VARIABLES: Rivet Young's Modulus and all rivet geometric variables can be used, such as rivet diameter and length.

OUTPUT: The Load in the rivet at joint failure.

JSAM4: ACM2 EQUIVALENT RIVET VALUE.



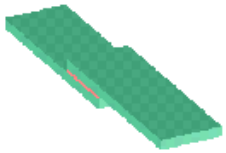
The JSAM4, calculates the equivalent self-piercing rivet diameter (ESRD) that would be used in place of a weld diameter, in the ACM2/NASTRAN program.

APPLICATION: This value is of particular significance when accurate determination of the car body torsional stiffness.

JOINT INPUT VARIABLES: Accepts Rivet geometry variables.

OUTPUT: Calculates the ESRD. This module has a database attached so that end user combinations may be logged and interrogated in MSC Access.

JSAM 5: ADHESIVE BONDED LAP JOINT STRENGTH. EQUAL THICKNESS ADHERENDS



This JSAM5 application calculates the Volkersen elastic failure strength of the adhesively bonded lap joint. This Jsam module is applicable to equal thickness adherends only. Offering a simpler input table.

APPLICATION: The Designer or Stress Engineer can use the JSAM5 tool to;

- Determine joint failure strength for existing joints. Helpful when trouble shooting.
- Conduct Parametric and Optimisation studies relating to joint geometry/strength variations.
- Calculate joint width required to sustain specific loading.

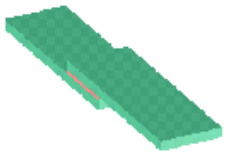
OPTIONS: Joint geometry may be varied until the optimum joint strength is achieved.

JOINT INPUT VARIABLES: The joint geometry parameters that may be varied are;

- Joint width.
- Joint thickness. (Note, Unequal joint coupon thickness are not accepted)
- Joint overlap.
- Joint materials. Note: The Top and bottom coupons may be of different materials.
- Ductile adhesive strength.
- Adhesive shear modulus.
- Adhesive laid-down thickness.

OUTPUT: Volkersen Elastic failure strength.

JSAM 6: ADHESIVELY BONDED LAP JOINT STRENGTH.



This JSAM6 application calculates the Volkersen elastic failure strength of the adhesively bonded lap joint.

APPLICATION: The Designer or Stress Engineer can use the JSAM6 tool to;

- Determine joint failure strength for existing joints. Helpful when trouble shooting.
- Conduct Parametric and Optimisation studies relating to joint geometry/strength variations.
- Calculate joint width required to sustain specific loading.

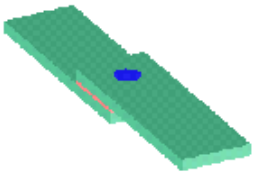
OPTIONS: Joint geometry may be varied until the optimum joint strength is achieved.

JOINT INPUT VARIABLES: The joint geometry parameters that may be varied are;

- Joint width.
- Joint thickness. Note, Unequal joint coupon thickness are accepted.
- Joint overlap.
- Joint materials. Note: The Top and bottom coupons may be of different materials.
- Ductile adhesive strength.
- Adhesive shear modulus.
- Adhesive laid-down thickness.

OUTPUT: Volkersen Elastic failure strength.

JSAM7: COMBINED RIVET AND ADHESIVE BONDED LAP JOINT STRENGTH



This JSAM7 tool calculates the strength of the combined Rivet/bond lap joint and displays its probable failure mode. The combined failure strength is determined using a mathematical approach that combines the ultimate failure strengths of the rivet joint with the Volkersen Elastic strength of the adhesive.

APPLICATION: The Designer or Stress Engineer can use the JSAM7 tool to;

- Determine joint failure strength and mode for existing joints. Helpful when trouble shooting.
- Conduct parametric and Optimisation studies relating to joint/rivet geometry variations.
- Rivet minimisation studies, ie Reduction of rivet count, eg, by changing joint adhesive-geometry.

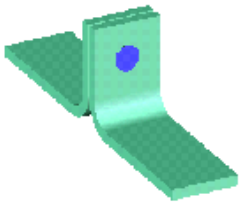
JOINT INPUT VARIABLES: Virtually any variation of Joint/rivet/adhesive configuration may be quickly explored for strength and failure mode. The parameters that may be varied in the calculation include;

- Joint width.
- Joint thickness. Note, that unequal joint coupon thickness are accepted.
- Coupon Stacks of more than two can be used. (See tutorial).
- Joint overlap.
- Joint materials.Note, Top and bottom coupons may be of different materials.
    a) Youngs Modulus.
    b) Material Strength.
- Rivet to joint edge distance.
- Rivet diameter.
- Number of rivets.
- Rivet material.
- Ductile adhesive strength.
- Adhesive shear modulus.
- Adhesive laid-down thickness.

OUTPUT: Ultimate failure strength and mode of failure of combined rivet/bond joint.
Failure modes displayed include;

- Bearing Failure.
- Shear out Failure.
- Net tension failure.

JSAM8: RIVETED T-PEEL JOINT STRENGTH.



This JSAM8 tool calculates the Failure strength of the riveted T-peel joint.

APPLICATION: The Designer or Stress Engineer can use the JSAM8 tool to;

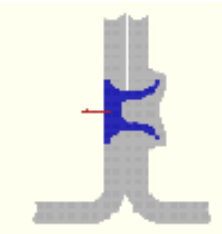
- Determine joint failure strength for existing joints. Helpful when trouble shooting.
- Conduct parametric and Optimisation studies relating to joint/rivet geometry variations.
- Rivet minimisation studies, ie Reduction of rivet count, by adjusting joint/rivet configuration geometry.

JOINT INPUT VARIABLES: Virtually any variation of Joint/rivet configuration may be quickly explored for failure strength.. The parameters that may be varied in the calculation include;

- Joint width.
- Joint thickness. Note, that unequal joint coupon thickness are accepted.
- Coupon Stacks of more than two can be used. (See tutorial).
- Joint overlap.
- Joint materials.Note, Top and bottom coupons may be of different materials.
    a) Youngs Modulus.
    b) Material Strength.
- Rivet to joint edge distance.
- Rivet diameter.
- Number of rivets.
- Rivet material.

OUTPUT: Ultimate failure strength

JSAM9: RIVET AXIAL LOAD AT T-PEEL JOINT FAILURE



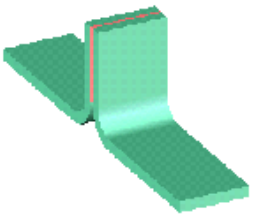
This JSAM9 tool calculates the axial Load in the rivet of the riveted T-peel joint at joint failure.

APPLICATION: This rivet load is then used in crash analysis software such as DYNA or other crash analysis software.

JOINT INPUT VARIABLES: Rivet Youngs Modulus and all rivet geometric variables can be used, such as rivet diameter and length.

OUTPUT: Calculates the axial Load in the rivet of the riveted T-peel joint at joint failure.

JSAM10: T-PEEL ADHESIVELY BONDED LAP JOINT STRENGTH.



This JSAM10 tool calculates the strength of the adhesively bonded T-peel joint.

APPLICATION: The Designer or Stress Engineer can use the JSAM10 tool to;

- Determine joint failure strength for existing joints. Helpful when trouble shooting.
- Conduct parametric and Optimisation studies relating to joint/rivet geometry variations.
- Rivet minimisation studies, ie Reduction of rivet count, by equivalencing rivet joint strength to adhesive joint strength.

OPTIONS: Joint geometry may be varied until the optimum joint strength is achieved.

JOINT INPUT VARIABLES: The joint geometry parameters that may be varied are;

- Joint width.
- Adhesive shear modulus.

- **LIMITATIONS:** Only for 90 degree angles. Analysis independent of,

- Adhesive laid-down thickness.
- Ductile adhesive strength.
- Joint overlap. However, typical overlap should be over 10mm to avoid the hyperbolic nature of the analytical
  relationship.
- Joint adherend thickness.
- Joint materials.

OUTPUT: Elastic failure strength.